

**CLAIMS**

1. A light source apparatus which is characterized in that: it has a light source by which a light flux whose emitting angle is different in a horizontal direction and in a vertical direction is projected, and a beam shaping element, for converting the light flux into a light flux whose emitting angle is almost equal and projecting, of a single lens formed of plastic in which a linear expansion coefficient  $\alpha_n$  satisfies the following expression (1)

$5.0 \times 10^{-5} < \alpha_n < 8.0 \times 10^{-5}$  (1), and a part of the beam shaping element is fixed and arranged to the light source, so that an astigmatism generated following the refractive index change of the beam shaping element generated by the temperature change is suppressed by an interval change, which is generated by the linear expansion of the beam shaping element, between the light source and the incident surface of the beam shaping element.

2. A light source apparatus written in Claim 1, wherein, in the beam shaping element, an outgoing surface is fixed so

that it is not practically changed in the optical axis direction to the light source.

3. A light source apparatus written in Claim 2, wherein the beam shaping element is structured so that the astigmatism generated by the temperature change is suppressed by using the astigmatism generated following the shape change due to the temperature change of the beam shaping element.

4. A light source apparatus written in Claim 3, wherein a fixing member for fixing the beam shaping element outgoing surface is formed of a material whose linear expansion coefficient satisfies  $1.0 \times 10^{-5} < \alpha n < 3.0 \times 10^{-5}$ .

5. A light source apparatus written in Claim 4, wherein, in the beam shaping element, a cross sectional shape in the horizontal direction or in the vertical direction of the at least one optical surface of the incident surface and the outgoing surface is non-circular arc.

6. A light source apparatus written in Claim 5, wherein the surface shape of the beam shaping element incident surface satisfies the following Math-1 or Math-2.

[Math-1]

$$(Z - R_x)^2 + X^2 = \left( R_x - \frac{Y^2}{R_y(1 + \sqrt{1 - (1 + k_y)Y^2/R_y^2})} + \sum_i A_{yi} Y^i \right)^2$$

[Math-2]

$$(Z - R_y)^2 + Y^2 = \left( R_y - \frac{X^2}{R_x(1 + \sqrt{1 - (1 + k_x)X^2/R_x^2})} + \sum A_{xi} X^i \right)$$

Hereupon, Z is a distance in the optical axis direction (Z-axis direction) (an advancing direction of the light is positive), X, Y are distances in X-axis direction (horizontal direction), Y-axis direction (vertical direction) (height from the optical axis),  $R_x$  is a paraxial radius of curvature on XZ surface,  $R_y$  is a paraxial radius of curvature on YZ surface,  $k_x$ ,  $k_y$ ,  $A_{xi}$  and  $A_{yi}$  are non-circular arc coefficients.

7. A light source apparatus written in Claim 6, wherein the surface shape of the beam shaping element outgoing surface satisfies the following Math-3 or Math-4.

[Math-3]

$$(Z - R_x)^2 + X^2 = \left( R_x - \frac{Y^2}{(1 + \sqrt{1 - Y^2/R_y^2})} \right)$$

[Math-4]

$$(Z - R_y)^2 + Y^2 = \left( R_y - \frac{X^2}{(1 + \sqrt{1 - X^2/R_x^2})} \right)$$

8. A light source apparatus written in Claim 1, wherein the surface shape of the beam shaping element outgoing surface satisfies the following Math-1 or Math-2.

[Math-1]

$$(Z - R_x)^2 + X^2 = \left( R_x - \frac{Y^2}{R_y(1 + \sqrt{1 - (1 + k_y)Y^2/R_y^2})} + \sum_i A_{yi} Y^i \right)^2$$

[Math-2]

$$(Z - R_y)^2 + Y^2 = \left( R_y - \frac{X^2}{R_x(1 + \sqrt{1 - (1 + k_x)X^2/R_x^2})} + \sum A_{xi} X^i \right)$$

Hereupon, Z is a distance in the optical axis direction (Z-axis direction) (an advancing direction of the light is positive), X, Y are distances in X-axis direction (horizontal direction), Y-axis direction (vertical direction) (height from the optical axis), R<sub>x</sub> is a paraxial radius of curvature on XZ surface, R<sub>y</sub> is a paraxial radius of curvature on YZ surface, k<sub>x</sub>, k<sub>y</sub>, A<sub>xi</sub> and A<sub>yi</sub> are non-circular arc coefficients.

9. A light source apparatus written in Claim 8, wherein the surface shape of the beam shaping element incident surface satisfies the following Math-3 or Math-4.

[Math-3]

$$(Z - R_x)^2 + X^2 = \left( R_x - \frac{Y^2}{(1 + \sqrt{1 - Y^2 / R_y^2})} \right)$$

[Math-4]

$$(Z - R_y)^2 + Y^2 = \left( R_y - \frac{X^2}{(1 + \sqrt{1 - X^2 / R_x^2})} \right)$$

10. An optical pick-up apparatus which characterized in that: it is provided with a light source apparatus written in Claim 7 and a light converging element for converging the light flux on the information recording surface of the optical information recording medium, and the reproducing and/or recording of the information is conducted on the optical information recording medium.

11. An optical pick-up apparatus written in Claim 10, wherein it has a divergent angle converting element for converting the divergent angle of the light flux projected from the beam shaping element outgoing surface, and it is structured so as to satisfy the following relational expression.

$$0.5 < (L/S) \times f_c < 1.0$$

Hereupon, L: thickness on axis (mm) of the beam shaping element

S: distance (mm) on the optical axis between light source and the beam shaping element incident surface,

fc: focal distance (mm) of the divergent angle converting element

12. An optical pick-up apparatus written in Claim 11, wherein the divergent angle converting element is a coupling lens for converting the light flux projected from the beam shaping element into a parallel light parallel to the optical axis.

13. An optical pick-up apparatus which characterized in that: it is provided with a light source apparatus written in Claim 9 and a light converging element for converging the light flux on the information recording surface of the optical information recording medium, and the reproducing and/or recording of the information is conducted on the optical information recording medium.

14. An optical pick-up apparatus written in Claim 13, wherein it has a divergent angle converting element for

converting the divergent angle of the light flux projected from the beam shaping element outgoing surface, and it is structured so as to satisfy the following relational expression.

$$1.5 > (L/S) \times f_c > 1.0$$

Hereupon, L: thickness on axis (mm) of the beam shaping element

S: distance (mm) on the optical axis between light source and the beam shaping element incident surface,

f<sub>c</sub>: focal distance (mm) of the divergent angle converting element

15. An optical pick-up apparatus written in Claim 14, wherein the divergent angle converting element is a coupling lens for converting the light flux projected from the beam shaping element into a parallel light parallel to the optical axis.

16. A light source apparatus written in Claim 1, wherein the beam shaping element is structured so that the astigmatism generated by the temperature change is suppressed by using the astigmatism generated following the shape change due to the temperature change of the beam shaping element.

17. A light source apparatus written in Claim 1, wherein a fixing member for fixing the beam shaping element outgoing surface is formed of a material whose linear expansion coefficient satisfies  $1.0 \times 10^{-5} < \alpha_n < 3.0 \times 10^{-5}$ .

18. A light source apparatus written in Claim 1, wherein, in the beam shaping element, a cross sectional shape in the horizontal direction or in the vertical direction of the at least one optical surface of the incident surface and the outgoing surface is non-circular arc.

19. A light source apparatus written in Claim 18, wherein the surface shape of the beam shaping element incident surface satisfies the following Math-1 or Math-2.

[Math-1]

$$(Z - R_x)^2 + X^2 = \left( R_x - \frac{Y^2}{R_y(1 + \sqrt{1 - (1 + k_y)Y^2/R_y^2})} + \sum_i A_{yi} Y^i \right)^2$$

[Math-2]

$$(Z - R_y)^2 + Y^2 = \left( R_y - \frac{X^2}{R_x(1 + \sqrt{1 - (1 + k_x)X^2/R_x^2})} + \sum_i A_{xi} X^i \right)^2$$

Hereupon, Z is a distance in the optical axis direction (Z-axis direction) (an advancing direction of the light is

positive), X, Y are distances in X-axis direction (horizontal direction), Y-axis direction (vertical direction) (height from the optical axis),  $R_x$  is a paraxial radius of curvature on XZ surface,  $R_y$  is a paraxial radius of curvature on YZ surface,  $k_x$ ,  $k_y$ ,  $A_{xi}$  and  $A_{yi}$  are non-circular arc coefficients.

20. A light source apparatus written in Claim 19, wherein the surface shape of the beam shaping element outgoing surface satisfies the following Math-3 or Math-4.

[Math-3]

$$(Z - R_x)^2 + X^2 = \left( R_x - \frac{Y^2}{(1 + \sqrt{1 - Y^2/R_y^2})} \right)$$

[Math-4]

$$(Z - R_y)^2 + Y^2 = \left( R_y - \frac{X^2}{(1 + \sqrt{1 - X^2/R_x^2})} \right)$$

21. A light source apparatus written in Claim 18, wherein the surface shape of the beam shaping element outgoing surface satisfies the following Math-1 or Math-2.

[Math-1]

$$(Z - R_x)^2 + X^2 = \left( R_x - \frac{Y^2}{R_y(1 + \sqrt{1 - (1 + k_y)Y^2/R_y^2})} + \sum_i A_{yi} Y^i \right)^2$$

[Math-2]

$$(Z - R_y)^2 + Y^2 = \left( R_y - \frac{X^2}{R_x(1 + \sqrt{1 - (1 + k_x)X^2/R_x^2})} + \sum A_{xi} X^i \right)$$

Hereupon, Z is a distance in the optical axis direction (Z-axis direction) (an advancing direction of the light is positive), X, Y are distances in X-direction direction (horizontal direction), Y-direction (vertical direction) (height from the optical axis), R<sub>x</sub> is a paraxial radius of curvature on XZ surface, R<sub>y</sub> is a paraxial radius of curvature on YZ surface, k<sub>x</sub>, k<sub>y</sub>, A<sub>xi</sub> and A<sub>yi</sub> are non-circular arc coefficients.

22. A light source apparatus written in Claim 21, wherein the surface shape of the beam shaping element incident surface satisfies the following Math-3 or Math-4.

[Math-3]

$$(Z - R_x)^2 + X^2 = \left( R_x - \frac{Y^2}{(1 + \sqrt{1 - Y^2/R_y^2})} \right)$$

[Math-4]

$$(Z - R_y)^2 + Y^2 = \left( R_y - \frac{X^2}{(1 + \sqrt{1 - X^2/R_x^2})} \right)$$

23. An optical pick-up apparatus which characterized in that: it is provided with a light source apparatus written in Claim 1 and a light converging element for converging the light flux on the information recording surface of the optical information recording medium, and the reproducing and/or recording of the information is conducted on the optical information recording medium.

24. An optical pick-up apparatus written in Claim 23, wherein it has a divergent angle converting element for converting the divergent angle of the light flux projected from the beam shaping element outgoing surface, and it is structured so as to satisfy the following relational expression.

$$3.5 > (L/S) \times f_c > 1.0$$

Hereupon, L: thickness on axis (mm) of the beam shaping element

S: distance (mm) on the optical axis between the light source and the beam shaping element incident surface,

f<sub>c</sub>: focal distance (mm) of the divergent angle converting element

25. An optical pick-up apparatus written in Claim 24,  
wherein the divergent angle converting element is a coupling  
lens for converting the light flux projected from the beam  
shaping element into a parallel light parallel to the optical  
axis.